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Comprehensive Report to Congress Clean Coal Technology Program

Coal Diesel Combined-Cycle Project

A Project Proposed By:
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Washington, D.C. 20585

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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

1.0 EXECUTIVE SUMMARY

Public Law 102-154 provided funds to the U.S. Department of Energy (DOE) to conduct cost-shared Clean Coal Technology (CCT) Projects for the design, construction, and operation of facilities that "... shall advance significantly the efficiency and environmental performance of coal-using technologies and be applicable to either new or existing facilities ...". This Act, together with Public Law 101-512, made available a total of $600 million for a fifth general request for proposals under the Clean Coal Technology V (CCT-V) Program. To that end, a Program Opportunity Notice (PON) was issued by DOE in July 1992.

In response to the PON, 24 proposals were received by DOE in December 1992. After evaluation, five projects were selected for award. These projects use technologies that significantly advance efficiency and environmental performance and are applicable to either new or existing facilities.

One of the five projects selected for funding is a project proposed by a team consisting of Easton Utilities Commission, Cooper-Bessemer Reciprocating Products Division of Cooper Industries, Inc. (Cooper), and Arthur D. Little, Inc. (ADL) with additional support from the Ohio Coal Development Office (OCDO). The proposers requested financial assistance from DOE for the design, construction, and operation of a nominal 90 ton-per-day, 14-megawatt electrical (MWe), diesel engine-based, combined-cycle demonstration plant using coal-water fuels (CWF). The project, named the Coal Diesel Combined-Cycle Project, is to be located at a power generation facility at Easton Utilities Commission's Plant No. 2 in Easton, Talbot County, Maryland (Figure 1), and will use Cooper-Bessemer diesel engine technology. The demonstration plant will produce electrical power to serve Easton and the Delmarva Power & Light Company's power grid. The project, including the demonstration phase, will last 79 months at a total cost of $38,309,516. DOE's share of the project cost will be 50 percent. ADL will act as the prime contractor (Participant) for the project.

The objective of the proposed project is to demonstrate an advanced, coal diesel engine combined-cycle (CDCC) system in a small utility power plant. The integrated system performance to be demonstrated will involve all of the subsystems, including coal-cleaning and slurrying systems; a selective catalytic reduction (SCR) unit, a dry flue gas scrubber, and a baghouse; two modified diesel engines; a heat recovery steam generation system; a steam cycle; and the required balance of plant systems. The base feedstock for the project is bituminous coal from Ohio.

If the project is as successful as anticipated, it will demonstrate that integrated, coal-fueled, combined-cycle power plants based on the CDCC technology can be built at capital costs and thermal efficiencies which significantly reduce electric power costs over more conventional technologies for the 10- to 100-MWe range. The project will also demonstrate the effectiveness of

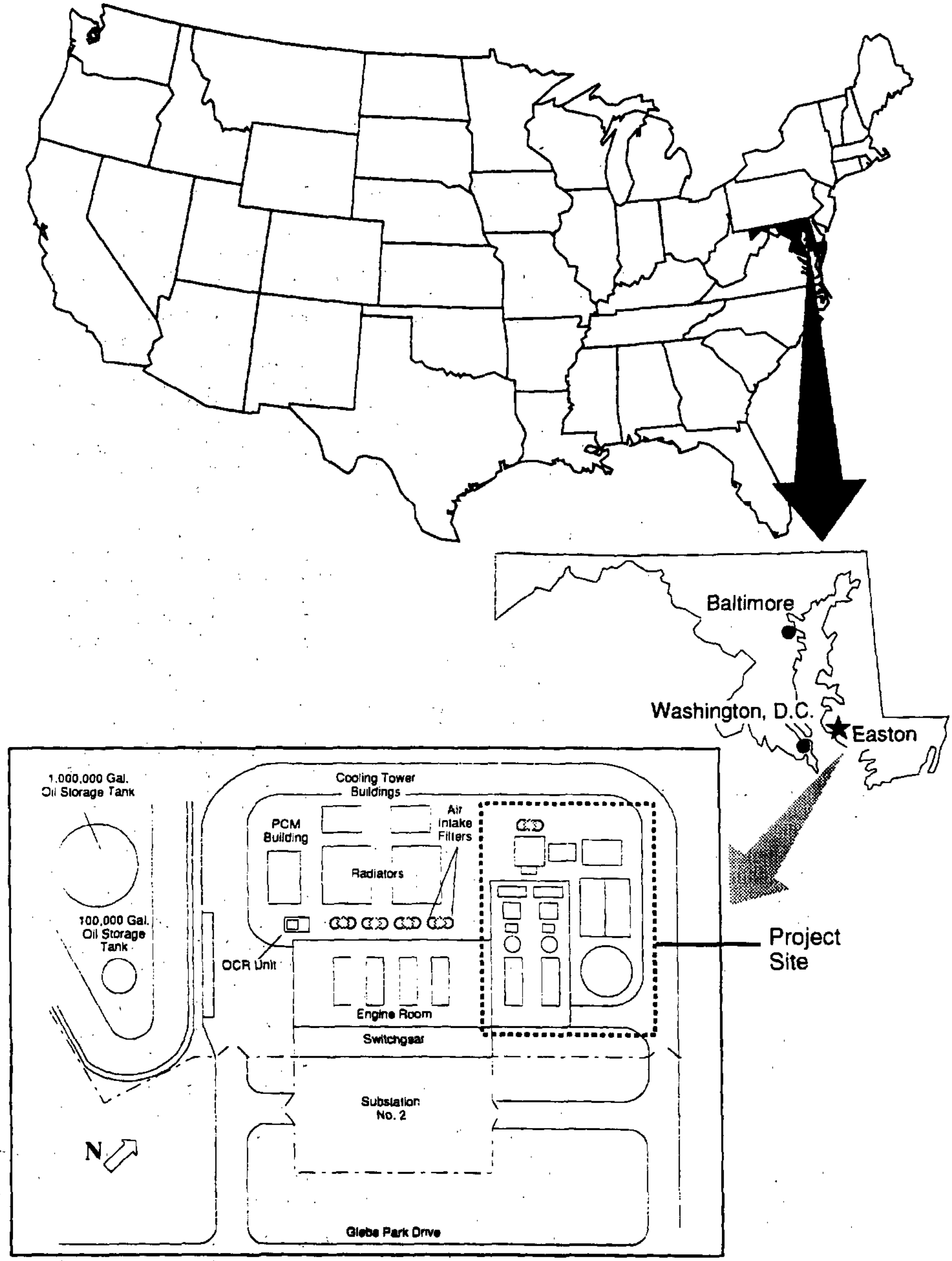

Figure 1. Project Location

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SCR and other downstream cleanup systems in achieving a negligible environmental impact with eastern bituminous coal.

2.0 INTRODUCTION AND BACKGROUND

2.1 REQUIREMENT FOR A REPORT TO CONGRESS

On November 13, 1991, Public Law 102-154, the Department of the Interior and Related Agencies Appropriations Act, 1992 (Act), was signed into law. This Act, among other things, provided funds to DOE to conduct cost-shared CCT projects for design, construction, and operation of facilities that "...shall advance significantly the efficiency and environmental performance of coal-using technologies and be applicable to either new or existing facilities...". This Act directed DOE to issue the fifth solicitation of the CCT Program no later than July 6, 1992, and specified that selection of projects for negotiations shall take place "...not later than ten months after the issuance date of the fifth general request for proposals...".

The Act, together with Public Law 101-512, made available a total of $600 million for the fifth general request for proposals under the CCT Program. Of these monies, $7.2 million were required to be reprogrammed for the Small Business and Innovative Research Program and $25.0 million were designated as Program Direction funds for costs incurred by DOE in implementing the CCT-V Program. All of the remaining appropriated funds, $567.8 million, were available for Award under the CCT-V PON.

The purpose of this Comprehensive Report is to comply with Public Law 102-154, which directs the DOE to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-V Program.

2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on April 20, 1992, receiving a total of 42 responses from the public. The final PON was issued on July 6, 1992, and took into consideration the public comments on the draft PON. On December 7, 1992, DOE received 24 proposals in response to the CCT-V solicitation. One proposal, which was received after the deadline date, did not qualify under any of the exceptions for late proposals specified in the PON and was, thereby, not considered in the evaluation process.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-V solicitation was to obtain "proposals to conduct cost-shared demonstration projects that advance significantly the efficiency and environmental performance of coal-using technologies and that are applicable to either new or existing facilities."

2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "In order to be considered in the Preliminary Evaluation Phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed Demonstration Facility must be located in the U.S.

(b) The proposed Demonstration Facility must be designed for and operated with coal. These coals must be from mines located in the U.S.

(c) The Proposer must agree to provide a cost share of at least 50 percent of total allowable project cost, with at least 50 percent in each of the Budget Periods.

(d) The Proposer must have access to, and use of, the proposed site of the Demonstration Facility and any proposed alternate site for the duration of the Demonstration Project.

(e) The proposed Project Team must be identified and firmly committed to fulfilling its proposed role in the project.

(f) The Proposer agrees that, if selected, it will submit a "Repayment Agreement" consistent with Section 7.7.

(g) The Proposal must be signed by a responsible official of the proposing organization authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive Evaluation phase, a proposal must be consistent with the stated objectives of the PON and must contain sufficient finance, management, technical, cost, and other information to permit the Comprehensive Evaluation described in the solicitation to be performed.

2.2.4 Comprehensive Evaluation

The Technical Evaluation criteria were divided into two major categories: (1) the Demonstration Project Factors were used to assess the technical and environmental merit of the project and the technical and management approaches to execute the project and (2) the Commercialization Factors were used to assess the potential of the proposed technology to significantly improve environmental performance and efficiency in new or existing facilities and to achieve wide commercial acceptance.

The Cost and Finance Evaluation criteria were used to determine the business performance potential and commitment of the proposer.

The PON provided that the Cost Estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that the Cost and Finance Evaluation criteria were of least importance to the selection, and that successful proposers would be required to submit a more detailed cost estimate after selection and before award. Proposers were cautioned that if the total project cost estimate after selection was greater than the amount specified in the proposal, DOE would be under no obligation to increase the amount of funding above that which was requested in the proposal.

2.2.5 Program Policy Factors

The PON advised proposers that the following Program Policy Factors would be considered by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of Environmental Health, Safety, and Socioeconomic regulatory and climatic conditions.

The word "collectively," as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior CCT solicitations, as well as other ongoing demonstrations in the U.S.

2.2.6 Other Considerations

The PON provided that in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the CCTs the same as pollution control projects or technologies. This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the CCT Program developed a procedure for compliance with the NEPA, the Council on Environmental Quality NEPA regulations (40 CFR

Parts 1500-1508), and the DOE guidelines for compliance with NEPA (52 FR 47662, December 15, 1987). DOE final NEPA regulations replacing the DOE guidelines were published in the Federal Register on April 24, 1992 (57 FR 15122) and are now codified at 10 CFR Part 1021. This procedure included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146) issued in November 1989, and the preparation of confidential preselection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA.

2.2.8 Selection

After considering the evaluation criteria, the program policy factors, and the NEPA strategy as stated in the PON, the Source Selection Official selected five projects as best furthering the objectives of the CCT-V PON. These selections were announced on May 4, 1993, during a press conference.

3.0 TECHNICAL FEATURES

3.1 PROJECT DESCRIPTION

The Coal Diesel Combined-Cycle Project proposed by the Easton team is to demonstrate an advanced CDCC System, based on two of Cooper-Bessemer's 20-cylinder diesel engines (Figure 2). The CDCC system, which utilizes CWF, will demonstrate high-efficiency, cost-competitive, environmentally compliant electric power generation. The system includes an integrated emission control system capable of reducing pollutants while protecting the engine's turbocharger and maintaining high engine and overall system efficiency. This demonstration project will provide critical data on the performance, reliability, and component life information of all major subsystems, including the CWF metering and injection system, medium speed diesel, lube oil protection system, exhaust cyclone, turbocharger, heat recovery steam boiler, steam turbine, and exhaust emission cleanup system.

The project activities include engineering and design, permitting, procurement, construction, start-up, and demonstration. The site of the demonstration is Easton Utilities Commission's Power Plant No. 2, located in Easton, Maryland. The plant will serve Easton and the Delmarva Power & Light Company's power grid. The demonstration facility will be installed as a two-diesel, 14-MWe extension of the existing 25-MWe generating plant. The project will utilize two 20-cylinder engines configured in a typical commercial arrangement and operated with CWF produced from Ohio bituminous coal. A total of 6,000 engine hours of CWF operation is planned for the demonstration project at Easton. An additional 1,000 hours of CWF testing will be conducted on a 6-cylinder engine at Cooper's test facility in Mount Vernon, Ohio. The CWF will be produced at a mine in Sugarcreek, Ohio.

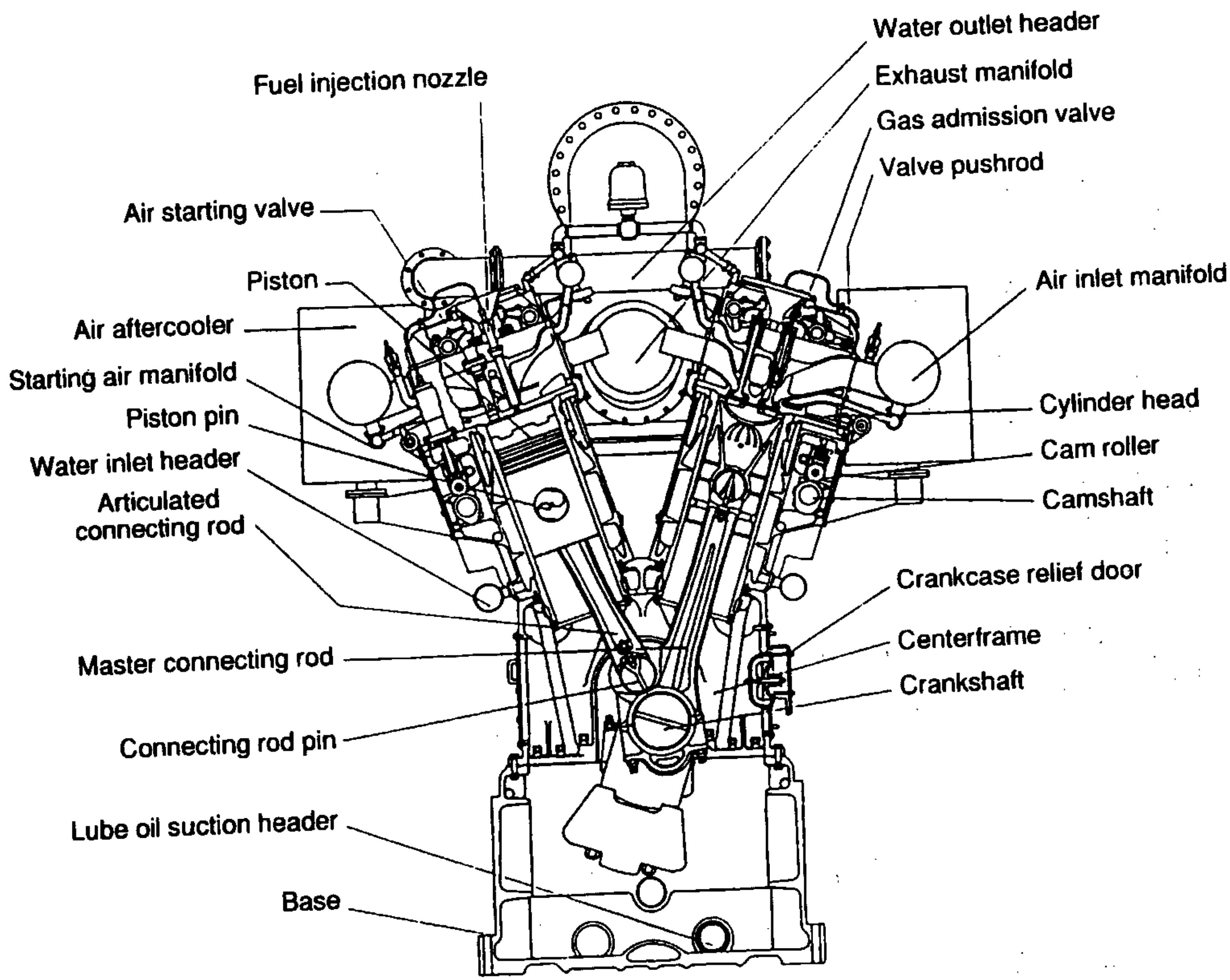

Figure 2. Cooper-Bessemer LSV Dual Fuel Engine Cross-Section

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3.1.1 Project Summary

Title:	Coal Diesel Combined-Cycle Project.
Proposer:	Easton Utilities Commission; Cooper-Bessemer Reciprocating Products; Arthur D. Little, Inc.
Location:	Easton Utilities Commission Plant No. 2, Easton, Maryland.
Technology:	Diesel engine combined-cycle technology using coal-water fuel.
Applications:	10- to 100-MWe non-utility generation (NUG); small utility repowering; cogeneration.
Type of Coal Used:	Eastern bituminous from Miller Mining in Sugarcreek, Ohio.
Products:	Electric power.
Project Size:	14 MWe, 90 tons of coal per day.
Project Start Date:	June 1994.
Project End Date:	January 2001.

3.1.2 Project Sponsorship and Cost

Project Participant:	Arthur D. Little, Inc.
Project Co-Funders:	Easton Utilities Commission; Cooper-Bessemer Reciprocating Products; Ohio Coal Development Office; and the U.S. DOE.
Estimated Project Cost:	$38,309,516.
Cost Distribution:	Participant Share, 50 percent. DOE Share, 50 percent.

3.2 DIESEL ENGINE COMBINED-CYCLE PROCESS

3.2.1 Overview of Process Development

For more than a decade, DOE has sponsored the development of medium-speed, coal-fueled diesel engines. The proposed demonstration is based on an extensive development program initiated in 1987 when DOE issued a contract with ADL/Cooper for coal-fueled diesel research and development. The program began as an exploratory effort and grew into a proof-of-concept program. DOE has maintained contractual commitments with ADL/Cooper for development of a coal-fueled diesel engine through the present. This research and development program reached a significant milestone with the operation of a full scale 6-cylinder diesel engine (same bore and stroke as that proposed for the Clean Coal Project) for over 225 hours on CWF. The longest continuous engine run was approximately 70 hours. A total of more than 1,050 hours of CWF operation has been logged on Cooper-Bessemer engines. Over 440 hours of CWF testing have been accumulated on a single-cylinder research engine. In addition, over 225 hours have been accumulated on the 1.8-MWe, 6-cylinder engine with a full-scale emissions control system at Mount Vernon, Ohio. The proposed 6,000 engine hours of CWF operation on a 20-cylinder engine under this project is the next step toward commercialization of the coal-fueled diesel power plant. An additional 1,000 hours of CWF testing will be conducted on a 6-cylinder engine at Cooper's test facility in Mount Vernon, Ohio.

DOE has also sponsored the development of high-speed, coal-fueled diesel engines through General Electric (GE) Transportation Systems in Erie, Pennsylvania for the past 5 years. After encouraging exploratory research, GE developed the necessary components to prove the concept of coal-fueled diesel engines, including the cleanup system that will control particulates and oxides of nitrogen and sulfur to exhaust levels significantly below present diesel locomotives. GE has successfully operated a full-scale, 12-cylinder diesel engine on CWF in a test cell and in track tests.

3.2.2 Process Description

The clean coal diesel technology is based on today's stationary diesel and dual-fueled engine power plants, modified by novel technology so that clean-coal fuel can be burned much like heavy fuel oil. The process used for the Coal Diesel Combined-Cycle Project demonstration consists of CWF preparation, two coal-fired diesel engines, a combined-cycle power generation block, and emission control subsystems (Figure 3).

Ohio No. 4, No. 5, and No. 6 bituminous coals will be mined at Sugarcreek, Ohio, and cleaned to 2 percent ash content. The CWF will be prepared from these 2 percent-ash coals near the mine site and delivered to Easton Utilities Commission's Plant No. 2 at Easton, Maryland, by tank trucks (6,500 gallon capacity).

The demonstration project will incorporate two Cooper-Bessemer LSV-20 engine models. These engines will be four-stroke diesel engines (15.5-inch bore by 22-inch stroke) with 20 cylinders, rated at 400 revolutions-per-minute and 208 pounds-per-square-inch brake mean effective pressure. Each engine will be coupled to a 6.3-MWe generator and will consume 7,228 pounds-per-hour (pph) of CWF and 84 pph of diesel pilot fuel. Each cylinder will have one CWF injector, and each nozzle tip will have 18 orifice inserts.

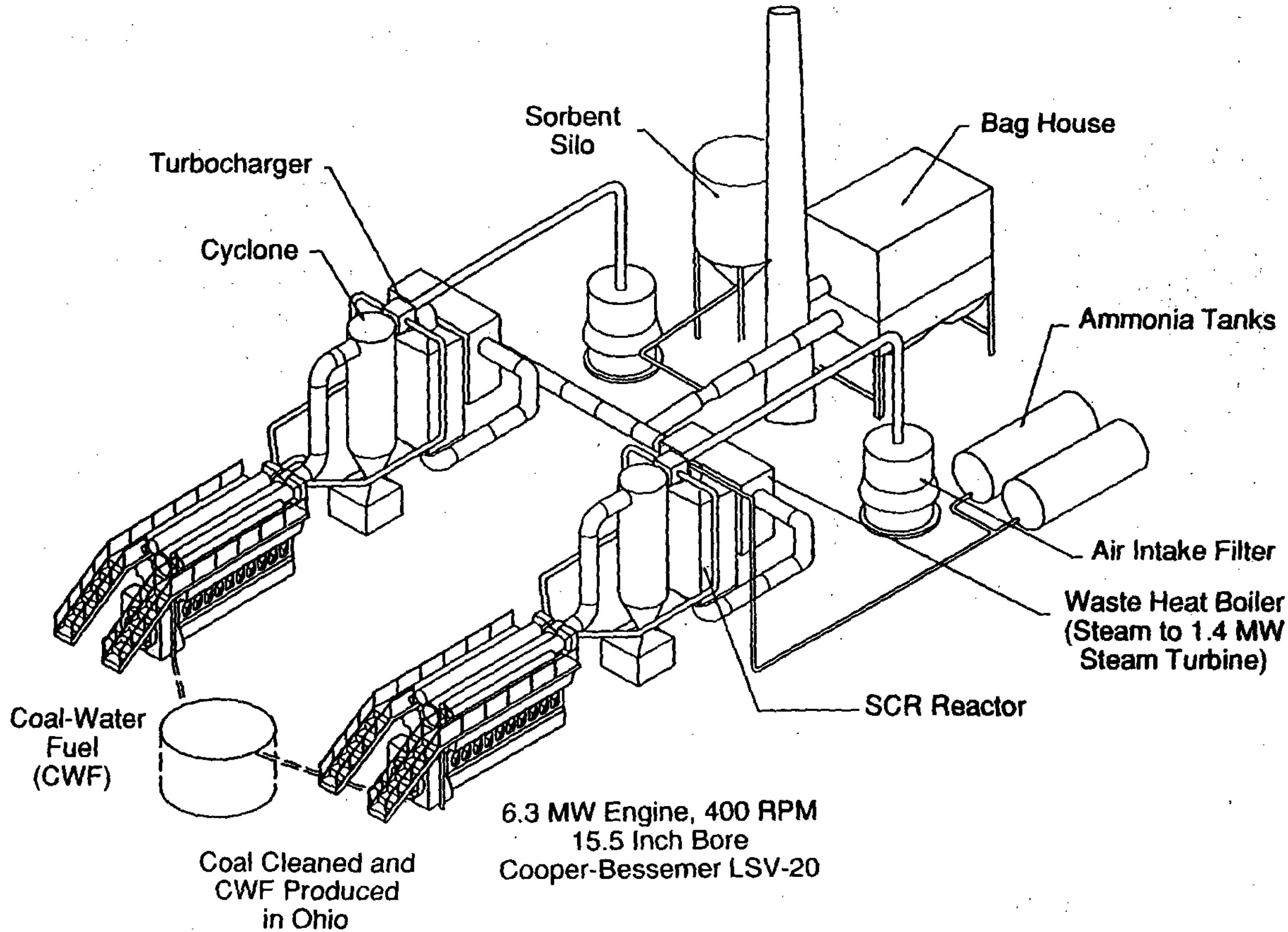

Figure 3. 14 MW Coal Diesel Combined-Cycle Power Plant

Engine exhaust at 850 °F will be sent to cyclones to remove the larger particles. The cyclones will be designed to remove 80 percent of the 20-micrometer particles and 50 percent of the 5-micrometer particles with approximately a 6-inch water pressure drop. Cleaned gas will flow from the cyclone(s) to the turbocharger while solids will be removed from the underflow stream through a rotary valve.

Exhaust from the turbocharged engines will pass through a heat recovery boiler, producing steam that will drive a steam turbine. The clean coal diesel system will achieve 45 percent efficiency lower heating value (LHV) for the demonstration. Larger 10- to 15-MWe diesels with this same combined-cycle plant design could be expected to attain an efficiency of 48 percent. An added benefit of the combined-cycle design is that it provides the flexibility to produce steam when full power is not required.

To control emissions, an integrated coal-fueled diesel emissions control system is used. This system, designed for the clean coal demonstration, is comprised of the following seven subsystems: (1) in-cylinder NO_x reduction, (2) cyclone, (3) SCR reactor, (4) sorbent injection, (5) baghouse, (6) induced draft fan, and (7) flue gas sample conditioning and analysis. With this system, oxides of nitrogen, sulfur dioxide, and particulate matter are effectively reduced while maximizing the overall efficiency of the process.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as a part of the fact-finding process, DOE performed a detailed evaluation of the Coal Diesel Combined-Cycle Project and determined it to be reasonable and appropriate. The evaluation focused on the technical, schedule, and cost risks that are associated with the project. A team of experts, both within DOE and available under contract, contributed to the evaluation. The data base for the evaluation included Participant-furnished documentation and fact-finding discussions between DOE and the Participant.

The scope of the project includes design, construction, start-up, and operation of the facility. This facility will operate using two 20-cylinder Cooper-Bessemer engines for 6,000 engine hours on CWF to generate data that is critical for commercialization of this technology. To date, more than 1050 hours of CWF operation have been logged on Cooper-Bessemer engines. An additional 1,000 hours of CWF testing will be conducted on a 6-cylinder engine at Cooper's test facility in Mount Vernon, Ohio. The design of the demonstration plant will utilize information available from ongoing tests by Cooper on their 6-cylinder engine and emission control system. The technical feasibility is further discussed in Section 3.3.1.2.

The proposed project is expected to be completed in 79 months. The schedule shown in Section 6.2 allows sufficient time for the design, construction, start-up, and demonstration of this project. Based on information presented in the proposal and additional information submitted by the project team during fact finding, the schedule, which is dependent on completing NEPA requirements and the permitting process, was determined to be ambitious but reasonable. This determination is premised on the current assumption that an Environmental Assessment is the appropriate level of NEPA documentation. Should DOE determine that an Environmental Impact Statement is required, the schedule may change.

The cost estimate, evaluated during the fact-finding process, was prepared using conceptual engineering, equipment layout and structural drawings, significant vendor input, and in-house historical labor and material costs. The cost estimate was presented by work breakdown structure, by project phase, and by major equipment. Sufficient information was presented to allow a reasonableness evaluation of the cost estimate and a cost overrun analysis. A financial risk analysis program was used by DOE to evaluate the risk in the estimate. Based on the review and evaluation of the information provided, including cost estimating methodologies and pricing bases, DOE concludes that the estimated cost of the project is acceptable.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

Other than a few developmental projects, there are no demonstration- or commercial-scale projects similar to the Coal Diesel Combined-Cycle Project. Those developmental projects were described in Section 3.2.1. This project will be the first time that the CWF-based diesel engine combined-cycle technology will be demonstrated at a scale sufficient to illustrate its commercial potential.

3.3.1.2 Technical Feasibility

DOE's analysis concluded that an adequate data base exists to ensure success of the demonstration. In addition, technical contingency programs will be undertaken during the project to reduce any areas of risk; thus, the technical risk associated with the project is low. DOE recognizes, however, that technical uncertainties exist in the proposed project, primarily in the durability of diesel engine components and sustained performance of SCR subsystems. The technical risks associated with the engine that could affect the demonstration project are related to the long-term durability and reliability of key components such as nozzle tips, injector shuttle, check valves, CWF transfer pumps, exhaust valves, rings and liners, and turbocharger blades. The ability to accurately predict component life is limited by the short duration of operating experience to date on a full-scale cylinder. Reduction of this project risk will be addressed by operating a 6-cylinder test engine for 1,000 hours in Cooper's test facility at Mount Vernon, Ohio.

Although SCR systems have been used extensively on a variety of fuels, the available data for application of SCR with a coal-fired diesel engine are limited to less than 150 hours at the Cooper Mount Vernon facility. Some deactivation of the catalyst occurred during operation, but the activity was restored when the dust was removed from the catalyst. As a potential solution to this problem, a soot blower may be tested with the SCR unit prior to construction of the demonstration plant. The SCR risk could also be reduced by selecting a vendor that guarantees catalyst activity.

3.3.1.3 Resource Availability

All of the resources required for the project are available. Fifty percent of the funds have been committed by the participants, including a grant of $5 million from OCDO. Signed commitments/agreements for the remainder of financing required to meet the Participant's total cost-sharing obligation will be provided to the DOE by the end of Phase I. These commitments will include Easton Utilities Commission authorization to secure the technology development bonds.

The project team members are well qualified for this demonstration. ADL, a Massachusetts Corporation based in Cambridge, Massachusetts, is one of the world's oldest, largest and most diversified research, engineering, and consulting organizations. ADL will serve as the Participant for the project. Easton Utilities Commission is a municipal utility owned by the town of Easton, Maryland, with 15 operating diesel engines totaling 58 MWe capacity. Cooper is the nation's largest supplier of 1,000 to 8,700 horsepower stationary diesel and spark ignition engines. Cooper-Bessemer engines are widely used in small utility, cogeneration and independent power production facilities, as well as in the oil and gas production industry.

The participants have also selected the key contractors and suppliers for the demonstration project. CQ, Inc., has been selected for CWF preparation and delivery, and AMBAC International for the CWF injection system. The CWF will be prepared in Sugarcreek, Ohio, and shipped by truck to the Easton plant in Maryland. Miller Mining, in Sugarcreek, will provide the cleaned coal and the site for the CWF processing plant.

3.3.2 Relationship Between Project Size and Projected Scale-Up of Commercial Facility

The clean coal diesel plants of the future are targeted for the 10- to 100-MWe, small utility market and for NUGs, including both independent power producers and cogenerators. The proposers plan to offer a family of plant designs using the 3.8-MWe and 6.3-MWe size engines as building blocks. Since the engine being demonstrated is a 6.3-MWe 20-cylinder system, this project, if successful, will demonstrate the commercial embodiment of this technology. It is projected that the commercial embodiment will have an installed cost of $1,300/kW and an efficiency of 48.2 percent (LHV) compared to a cost of $1,600/kW and an efficiency of 45 percent for the demonstration project.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The demonstration project will be a full-scale application of a building block of the commercial version of the coal-fueled diesel engine technology. Key features of the commercial CWF diesel engine to be demonstrated include:

- that the Coal Diesel Combined-Cycle Project can operate with superior emission reduction and achieve an efficiency of 45 percent based on the LHV of the coal;
- that criteria pollutants can be controlled to at least one-half of the current New Source Performance Standards (NSPS);
- that the Cooper-Bessemer, coal-fueled diesel engine is ready for market commercialization;
- that the SCR process is effective for NO_x control when treating coal-fueled diesel engine exhaust;
- that the coal-fueled diesel can handle substantial power demand swings at peak- and low-demand periods.

4.0 ENVIRONMENTAL CONSIDERATIONS

The overall strategy for compliance with NEPA, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a preselection, project-specific environmental analysis; and a post-selection, site-specific environmental analysis. To satisfy the first element, DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146). In the PEIS, results derived from the Regional Emissions Database and Evaluation System were used to estimate the environmental impacts that might occur in 2010 if each technology were to reach full commercialization, capturing 100 percent of its applicable market. The environmental impacts were compared to the no-action alternative, which assumed continued use of conventional coal technologies through 2010, with new plants using conventional flue gas desulfurization (FGD) to meet NSPS. Table 1 shows the environmental characteristics of coal-fueled diesel engines, as described in the PEIS.

The second element of DOE's NEPA strategy for the CCT program involved preparation of a pre-selection environmental review based on project-specific environmental data and analyses that offerors supplied as part of their proposals. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and processes reasonably available to the offeror, practical mitigating measures such as the options for controlling discharges and for management of solid and liquid wastes, impacts of each proposed demonstration on the local environments, and a list of required permits. Finally, the risks and impacts of each proposed project were assessed. This analysis was provided for the Source Selection Official's use before the selection of proposals.

Table 1. Summary of environmental characteristics for coal-fueled diesel engines

Applicable coal sulfur content	Low, medium
SO_2 removal[a] (%)	80
NO_x reduction[b] (%)	90
Total suspended particulates[c] (lb/10^6 MMBtu)	0.03
Solid waste	Not applicable
Sulfur removed byproducts	Not applicable
Heat rate (Btu/kWh)	7520
Capacity factor (%)	65

[a]Sulfur removal to approximately 0.5 percent in the CWF is accomplished by advanced physical coal cleaning methods (ultrafine). Reduction of SO_2 level in the engine exhaust stream to the NSPS is accomplished using available technology.

[b]Test results show that NO_x emission level in the exhaust of a diesel engine burning coal-water mixture is about half of that of a similar engine burning No. 2 diesel fuel. An additional 80% reduction in NOx levels is expected from the SCR system.

[c]With 1 percent ash content in the coal-water mixture, particulate emissions are reduced by 96 percent in the exhaust system by use of high efficiency cyclones and a baghouse.

Source: Programmatic Environmental Impact Statement (DOE/EIS-0146), November 1989.

As the final element of the NEPA strategy, the Participant must submit to DOE the environmental information specified in Appendix J of the PON. This detailed site- and project-specific information will be used as the basis for the site-specific NEPA documents to be prepared by DOE. These documents will be prepared in full compliance with NEPA and the CEQ and DOE regulations for compliance with NEPA, and must be completed and approved before Federal funds are provided for any activity that would limit the choice of reasonable alternatives to the proposed action or have an adverse environmental impact. DOE has not made a final determination of the appropriate level of NEPA documentation for this project.

In addition to the NEPA requirements outlined above, the Participant must prepare and submit an Environmental Monitoring Plan (EMP) for the project following the guidelines provided in Appendix N of the PON. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

The proposed project at Easton would incorporate the use of low ash cleaned coal in CWF feedstock. Exhaust stream clean-up systems, including particle removal by cyclone and NO_x removal by SCR, would also be employed.

The Participant, in a draft Environmental Information Volume, has described the projected positive effects of installing additional engines at Easton which are coal-fueled instead of oil-fueled. Table 2 shows the difference in emission rates between oil-fueled and CWF-fueled engines for NO_x, SO_x, and particulates.

Table 2. Comparison of Engine Emissions

Pollutant	No. 6 Oil-Fueled Engine Emissions (lb/MMBtu)	CWF Engine Emissions (lb/MMBtu)	Difference in Emissions (%)
Nitrogen Oxides	3.10	0.20	-94
Sulfur Oxides	1.10	0.50	-59
Particulates	0.34	0.015	-96

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

The project team, consisting of Easton Utilities Commission and ADL were the joint proposers of this project. On July 28, 1993, the proposers named ADL as the prime contractor, or Participant, for the project. As the Participant, ADL will sign the Cooperative Agreement. Easton Utilities Commission and Cooper will be subcontractors to the prime. The specific subcontracts between the key parties, Easton, Cooper, and ADL, will be reviewed by DOE under the terms of the Cooperative Agreement. The project organization is depicted in Figure 4.

ADL will serve as the prime contractor for the project, coordinating all activities between the key subcontractors. ADL will

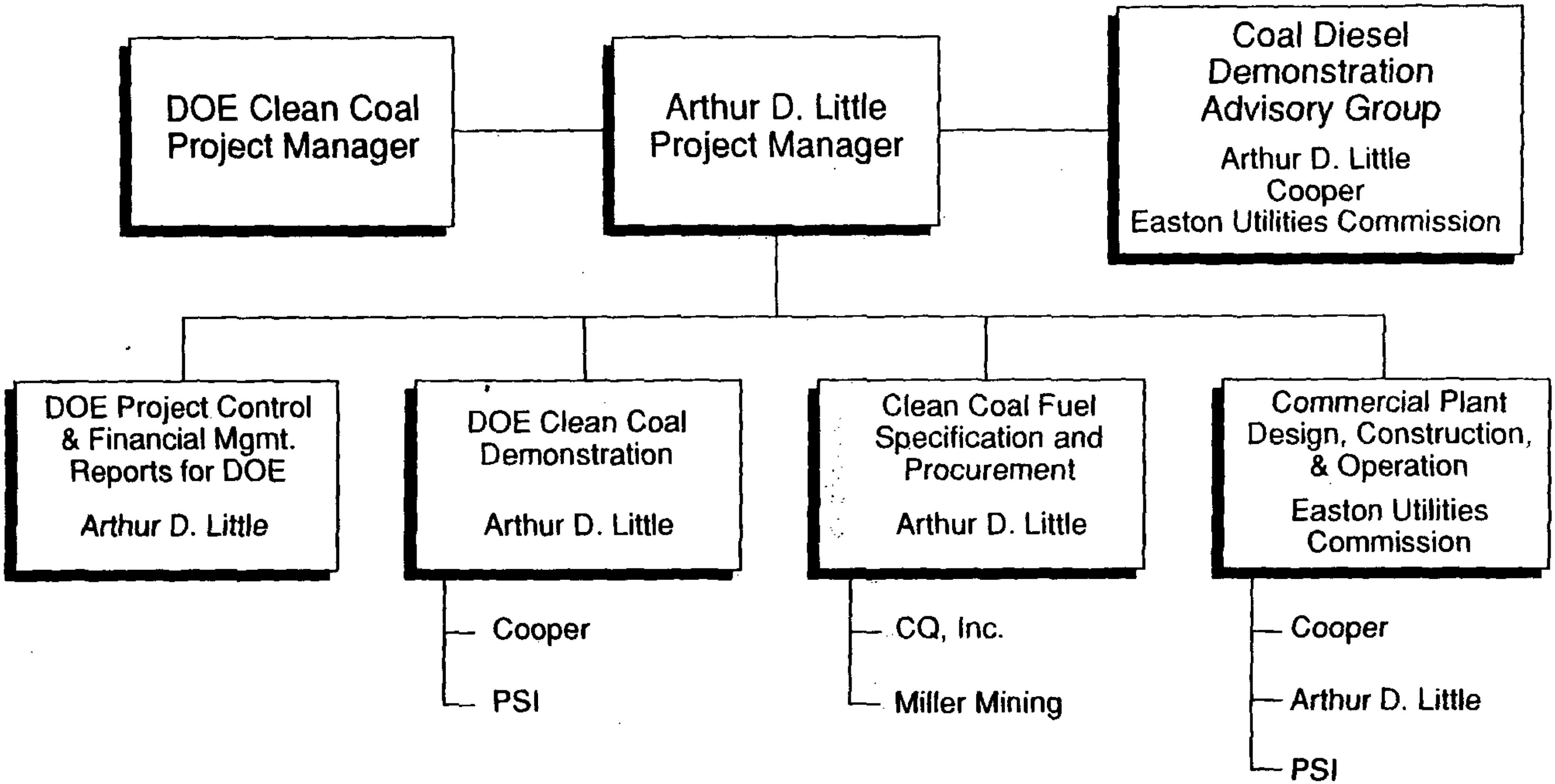

Figure 4. Project Management Structure

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have overall project management responsibilities and will be the interface with DOE on this project.

Cooper is a division of Cooper Industries, Inc. of Houston, Texas, and is based in Mount Vernon, Ohio. Cooper is a key subcontractor for performance of the project, and will co-sign the Repayment Agreement.

Easton Utilities Commission is a municipal utility owned by the town of Easton, Maryland. The demonstration project will be conducted at its Plant No. 2 in Easton, which has an existing capacity of 58 MWe.

CQ, Inc., is a Pennsylvania corporation based in Homer City, Pennsylvania. It is a small business that will provide the project with CWF for testing at Mount Vernon, Ohio, (6-cylinder laboratory-scale engine) and at Easton, Maryland, (20-cylinder demonstration-scale engines).

AMBAC International is a privately held Delaware corporation with offices in Springfield, Massachusetts. It will provide the project with the CWF injection system components. AMBAC is a key subcontractor which has worked extensively with the Cooper-Bessemer engine and has several critical patents related to the CWF injection system.

5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

5.2.1 DOE

DOE will be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. A DOE project manager will be designated by the DOE Contracting Officer to act as a Contracting Officer's Representative. The project manager will be the primary point of contact for the project and will be responsible for DOE's management of the project.

5.2.2 Participant

ADL, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection, and reporting. ADL will utilize the services of Cooper, Easton Utilities Commission, CQ Inc., and AMBAC International as key subcontractors for this project. ADL will designate a full-time project manager, who will be responsible for all technical and administrative activities to be performed under the Cooperative Agreement. This project manager will be the primary point of contact for interaction with DOE.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

ADL will prepare and maintain a Project Management Plan that presents project procedures, controls, schedules, budgets, and other activities required to adequately manage the project. This document, which will be finalized shortly after execution of the Cooperative Agreement, will be used to implement and control project activities. Throughout the course of the project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and delivered to DOE.

5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions that will generally provide for rights of access by DOE to all data generated or used in the course of or under the Cooperative Agreement for ADL and its subcontractors. DOE will have unlimited rights to data first produced in the performance of the Cooperative Agreement that is not proprietary nor protected Clean Coal Technology data, limited rights of access to proprietary data utilized in the course of the demonstration, and the right to use, but not disseminate for 5 years, protected Clean Coal Technology data. DOE will have the right to have relevant proprietary information delivered to it under suitable conditions of confidentiality.

With regard to patents, data, and other intellectual property, the Participant has made a contractual commitment to exercise its best efforts to commercialize the CWF based diesel engine technology as demonstrated in this project. To effect commercialization, the Participant has also made a contractual commitment to flow down their commercialization obligation in all contracts with suppliers of the technology to be demonstrated under this Cooperative Agreement.

The Participant has requested for itself, and on behalf of its subcontractors who will participate in the demonstration program, a waiver of patent rights in any subject invention, i.e., any invention or discovery by any of them that is conceived or first actually reduced to practice in the course of or under the Cooperative Agreement. Favorable action is anticipated to be given to the Participant's patent waiver request considering the level of cost sharing, the commitment by its principal subcontractor to commercialization of the CWF-based diesel engine technology, and agreement by the Participant to repay up to the Government's contribution in accordance with DOE guidelines. Any grant of a patent waiver will reserve to the Government a nonexclusive, nontransferable, and irrevocable paid-up license to practice or to have practiced any waived subject invention for or on behalf of the U.S.

5.5 PROCEDURES FOR COMMERCIALIZATION OF TECHNOLOGY

Design, construction, and operation of the Coal Diesel Combined-Cycle Project to demonstrate the CWF-based diesel engine technology with an integrated emission control system is a vital step toward widespread commercial application of this process. It is essential that a demonstration of the technology be conducted to produce long term reliability, availability, maintainability, and environmental performance at a scale sufficient to illustrate commercial potential. The project marks the first operation of this novel technology at a municipal utility scale. Demonstration of the technology with commercially available and large-scale equipment will provide valuable information for the private sector to use in making future commercialization decisions.

Cooper will be responsible for the overall commercialization of the technology with the assistance of ADL and other key members of the team. Cooper plans to work with and educate leading A&E firms in the introduction of the new coal-fueled diesel engines into the market place, with primary focus on 10- to 100-MWe NUGs and small utility power plants. Beginning in the 2000 to 2005 time frame, Cooper is projecting that coal diesels will capture approximately a 500-MWe market share of the NUG and small utility markets, which they project to be as large as 18,000 MWe. Cooper projects that the early market entries will be dual-fueled machines until the prices of oil and gas increase significantly.

ADL will contribute to the commercialization effort primarily by providing engineering and feasibility studies, market plans, fuel price forecasts, and continued technical refinement of specific components and subsystems of the engine and the emission control system.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the Cooperative Agreement are as shown below:

<u>Pre-award Cost</u>

DOE Share	$ 151,200	50.0%
Participant Share	$ 151,200	50.0%
	$ 302,400	100.0%

<u>Phase I</u>

DOE Share	$ 1,986,150	50.0%
Participant Share	$ 1,986,150	50.0%
	$ 3,972,300	100.0%

<u>Phase II</u>

DOE Share	$ 12,619,200	50.0%
Participant Share	$ 12,619,200	50.0%
	$ 25,238,400	100.0%

Phase III

DOE Share	$ 4,398,208	50.0%
Participant Share	$ 4,398,208	50.0%
	$ 8,796,416	100.0%

Total Estimated Project Cost

DOE Share	$ 19,154,758	50.0%
Participant Share	$ 19,154,758	50.0%
	$ 38,309,516	100.0%

Sequential budget period costs, dependent upon scheduling of activities in the project phases, shall be shared by DOE and the Participant as shown below. At the beginning of each budget period, DOE intends to obligate sufficient funds to pay its share of the expenses for that period.

TOTAL ESTIMATED PROJECT COST		$ 38,309,516
* Budget Period 1	DOE Share	$ 2,137,350
	Participant Share	$ 2,137,350
Budget Period 2	DOE Share	$ 12,734,282
	Participant Share	$ 12,734,282
Budget Period 3	DOE Share	$ 4,283,126
	Participant Share	$ 4,283,126

* Preaward costs are included in Budget Period 1.

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 79 months to complete. The phases and their expected durations are as shown below:

Phase I:	Design and Permitting	15 months
Phase II:	Construction and Start-up	31 months
Phase III:	Operation and Data Collection	40 months

Budget periods are used to manage the financial risk of the project and to facilitate project decision making. The project is divided into three sequential budget periods as follows:

Budget Period 1 -- 15 months
Budget Period 2 -- 28 months
Budget Period 3 -- 36 months

A project schedule is shown in Figure 5. Construction is expected to be completed by April 1998, and the project is expected to be completed by January 2001.

6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.7 of the PON, DOE is to recover an amount up to the Government's contribution to the project. Cooper has agreed to pay the Government in accordance with the Repayment Agreement to be executed at the time of award of the Cooperative Agreement.

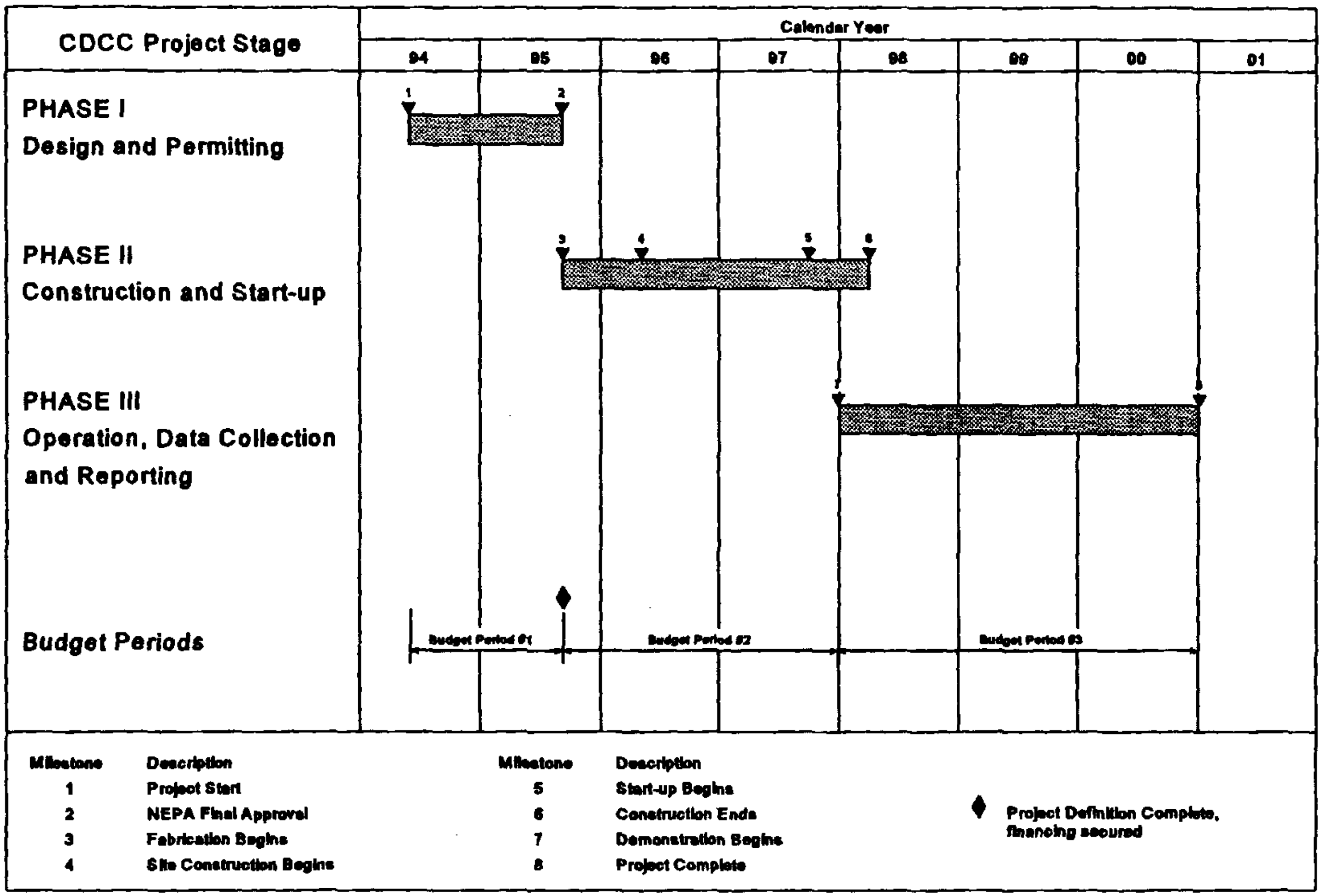

Figure 5. Coal Diesel Combined-Cycle Project Schedule